

Overview of 3D Engineered Models for Construction

November 20, 2013

1:00 pm – 2:30 pm EST



U.S. Department of Transportation
Federal Highway Administration

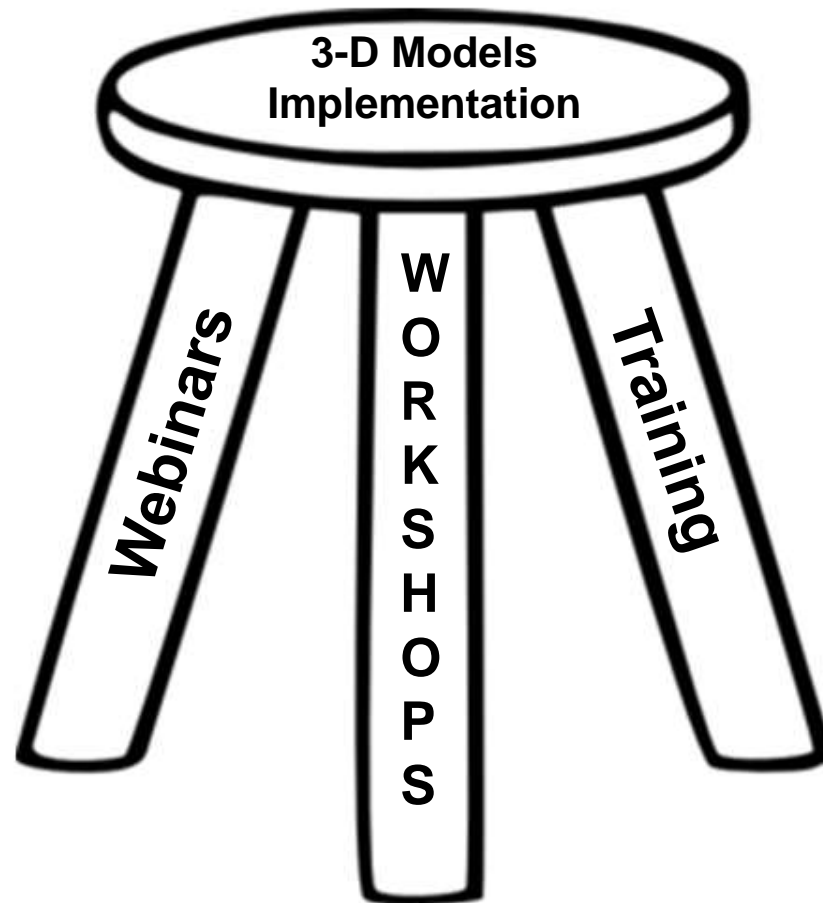


Why Webinars?

**Webinars are one of the three
legs of the 3-D Engineering
Models for Construction stool**



Why Webinars?



**Webinars are
one of the three
legs to
successful
implementation**



Target Audience for the Webinars

- **Government Owners
(DOTs, Counties, Cities, etc.)**
- **Consultants**
- **Contractors**
- **Industry**



1. Overview of 3D Models for Construction

November 20, 2013, 1:00 – 2:30 pm

- **FHWA Introduction**
- **DOT perspective**
- **Contractor perspective**



Agenda

Speaker	Topic
Rich Juliano (ARTBA)	Overview from the Contractor's Perspective
Bryan Cawley (FHWA-HQ)	Welcome & Overview of EDC2 3D Engineered Models for Construction Initiative
Dan Belcher (Michigan DOT)	Overview from the DOT's perspective
Alexa Mitchell (Missouri DOT)	Creating and Delivering 3D models for Construction
Eric Cylwik (Sundt Construction)	Using 3D models in Bidding and Construction
Douglas Townes (FHWA-RC)	Information on Next Webinar and Close
Francesca Maier (Parsons Brinckerhoff)	Summary and Audience Interaction

Contact: Douglas Townes, Phone 404-562-3914, douglas.townes@dot.gov

The Contractor Perspective

Rich Juliano
Senior Vice President
American Road & Transportation
Builders Association



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3D Modeling: MAP-21 Provisions

- Section 1304 – Innovative Project Delivery Methods
 - Projects including use of innovative technology may be eligible for greater federal share of funding
 - Examples include “digital 3-dimensional modeling techniques”
- Section 1503 – Project Approval and Oversight
 - The Secretary “shall encourage the use of advanced modeling technologies during environmental, planning, financial management, design, simulation, and construction processes of [federal-aid] projects.”
 - Compile information and industry best practices
 - Disseminate information and best practices to state DOTs
 - Develop and publish a comprehensive plan



AASHTO-ARTBA-AGC Joint Committee

- Policymaking group which includes these three national associations, with participation from FHWA
- 2012 Joint Position Statement: “Best Practices for Electronic Data-Sharing Between State DOTs and Contractors”
 - Prospective bidders should be provided all project electronic files
 - DOTs not expected to convert to vector format
 - Bidder can rely on data in static files as complete
 - For plans with cross-sections, vector files should also be provided; bidder responsible for verifying the accuracy of data
- Model liability limitation language to clarify designer’s responsibility



Some Further Thoughts from Industry...

- General Consensus
- “Horizontal” vs. “Vertical”
 - BIM
- Software and Contract Requirements
- Contractors Embrace Innovation
- FHWA’s Every Day Counts
- Contact: rjuliano@artba.org
- THANK YOU!



Poll Pod

3D Engineered Models for Construction

Bryan Cawley
Construction Management
Team Leader
Office of Infrastructure

Bryan.cawley@dot.gov 202-366-1333

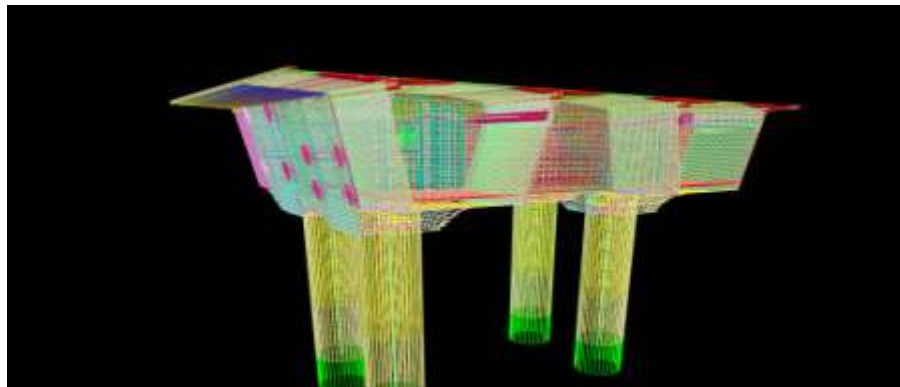


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3D Engineered Models for Construction

- Project represented in 3D, with accuracy and precision
 - Rotated, tilted, and manipulated to provide varying views
 - Perform “clash” analysis
 - Improved quality with quantity takeoffs
 - Digital Terrain Model (DTM) for Automated Machine Guidance (AMG)
- With 4D (time) virtual construction
- With 5D (money) cash flow





Overall Better Project Outcomes



Reduce Rework



Fewer Claims / Litigation



Reduce Errors in Documents



Reduce Workflow Cycle Time



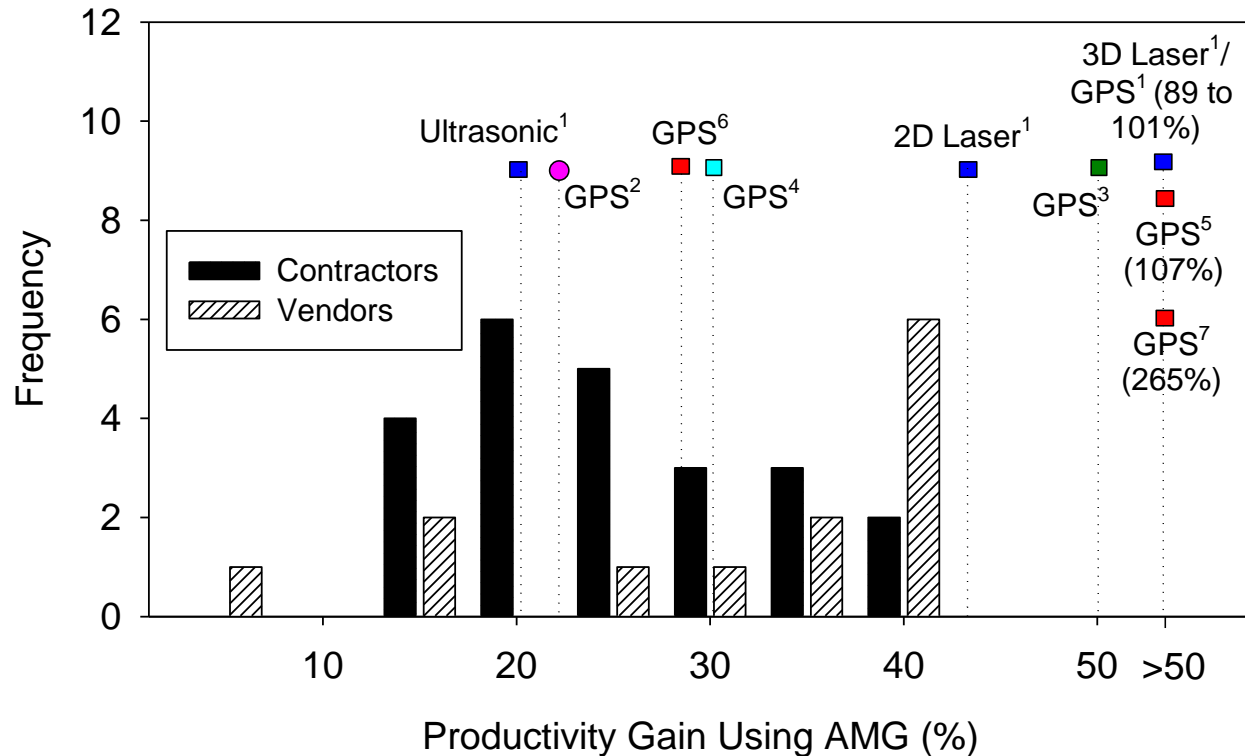
Reduce Project Duration



Reduce Construction Cost



Source: The Business Value
of BIM for Infrastructure,
McGraw Hill Construction,
2012



- Notes: ¹Fine-grading using CAT 140H motor grader (Jonasson et al., 2002)
²Trench excavation using CAT 330DL hydraulic excavator (Aðalsteinsson, 2008)
³Earth moving and fine grading (general values; not project specific) (Forrestel, 2007)
⁴Earth moving and fine grading project - Port of Brisbane (Higgins, 2009)
⁵Bulk earth moving and subgrade fine grading using CAT D6N dozer (gain in the number of passes; Caterpillar, 2006)
⁶Bulk earth moving using CAT 330D excavator (Caterpillar, 2006)
⁷Base course fine grading using CAT 140H motorgrader (gain the number of passes; Caterpillar, 2006)



Texas Legislature commissioned Texas A&M Institute Construction Innovations

- Design-Build/Just-in-Time Design/Design on the Fly
- 3-D Design
- Electronic Plans
- Delayed Closures to Accommodate Special Holidays
- Holiday/Event Black Out Period
- Night & Weekend Closures
- Wireless Paving
- Intelligent Compaction
- Smart Concrete Truck
- Asset Management through Equipment Telematics
- GPS-equipped Vehicles and Equipment
- Use of Rock for Retaining Wall Backfill
- Full Attack Construction/Aggressive Construction
- Highly Integrated City Coordination
- Selected Full Closure for Bridge Reconstruction
- Mobility Coordinator
- Night Utility Relocation
- Higher-Level Utility Coordination
- Consolidate Utility Efforts
- Pre-Cast Facilities/Pre-Cast In-Situ
- Recycling In-Place
- Use of Asphalt Pavement
- Pre-Cast Composite Steel/Concrete Caps
- Executive Meetings
- Scheduling Tools
- Play of the Day Meetings
- Weekly Coordination Meetings
- Co-location of All Offices
- Monthly 4-square matrix
- On-site Maintenance Shop
- Condition Appropriate Span Lengths
- Use of Recycled Rock Material in Lieu of Lime

<http://mobility.tamu.edu/mip/>



Advanced modeling techniques for enhanced constructability review: a survey of state practices and related research – Caltrans March 2012

- Benefits:
 - Time Savings: Visualization leads to faster decision-making; profiling is simpler and faster calculations for earthwork can be generated; more interactions of designs can be developed more quickly; and problems are more easily spotted and corrected earlier in the design process.
 - Cost Savings: Lower bids, lower survey costs and less rework; more accurate estimates; and fewer change orders and field modifications.
 - Quality: Ability to catch avoidable mistakes; earthwork calculations are more representative of the proposed project; and conflicts can be resolved before the bid process begins.
 - Improvements in Customer Relations: Builds belief in the design and confidence in the engineer-client relationship.
- Challenges:
 - Education and training, software limitations, and resistance to change.



3D Activities & tools

- National Website and Technical Support Service Center - Jan 2014
 - Specs, Details, Case Studies, etc.
 - Currently using: <http://www.efl.fhwa.dot.gov/technology/dv.aspx>
 - Technical Assistance
 - Inquiries from State DOTs, LPAs, Contractors & Engineers
- Webinars – Fall 2013 & throughout 2014
- 1-day Training – Spring 2014
- Demonstration Workshops
 - Design to Asphalt Pave – Oregon
 - Design to Construction of Steel Structures - Pennsylvania
 - Design to Concrete Slip-form Pave – Missouri
- Tech Briefs and Web-based Training – Summer 2014
 - NYState DOT – Steel Bridge Fabrication 3D Modeling
- Implementation Manuals – Summer 2014
 - Iowa DOT





More information

- More Information on EDC Technologies:
 - <http://www.fhwa.dot.gov/everydaycounts/>
- More Information on 3D Engineered Models for Construction
 - <http://www.efl.fhwa.dot.gov/technology/dv.aspx>
- ACPA Stringless Concrete Slip-Form Paving
 - <http://acpa.scholarlab.com/> Pavement1



3D Engineered Models for construction: Who can you contact?

- **Chris Schneider** FHWA Office of Infrastructure
christopher.schneider@dot.gov 202-493-0551
- **David Unkefer** FHWA Resource Center
david.unkefer@dot.gov 404-562-3669
- **Bryan Cawley** FHWA Office of Infrastructure,
bryan.cawley@dot.gov 202-366-1333
- **Douglas Townes** FHWA Resource Center
douglas.townes@dot.gov 404-562-3914
- **Kathryn Weisner** FHWA Resource Center,
kathryn.weisner@dot.gov 410-962-2484

3D Engineered Models for Construction from the DOT Perspective

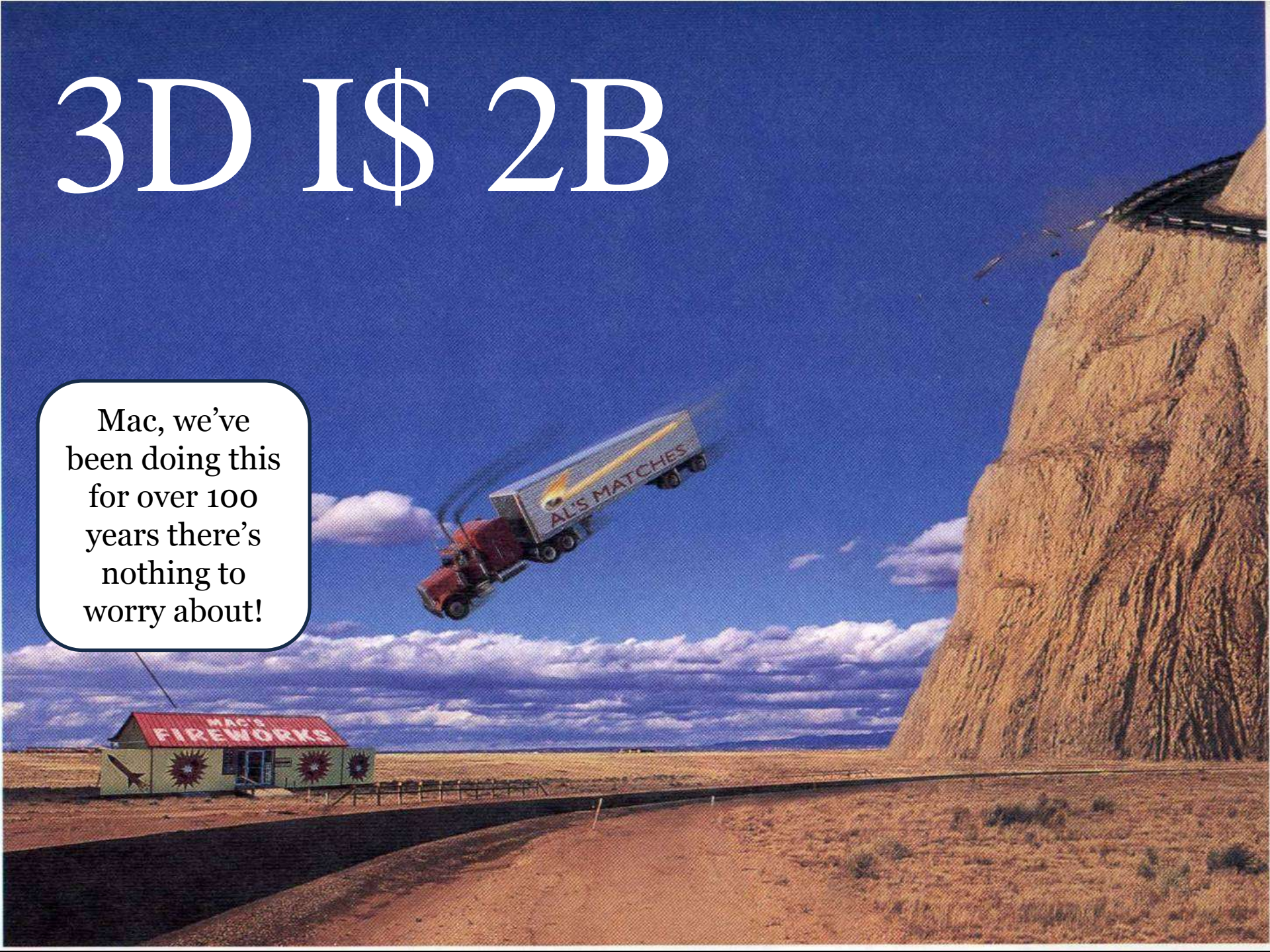
Daniel Belcher, P.E., P.S.
Michigan Department of
Transportation



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3D IS \$ 2B

Mac, we've
been doing this
for over 100
years there's
nothing to
worry about!



We Squeezed all the Efficiency Out of 2D CAD



Design



Courtesy Dean Bowman, Bentley Systems

Construction



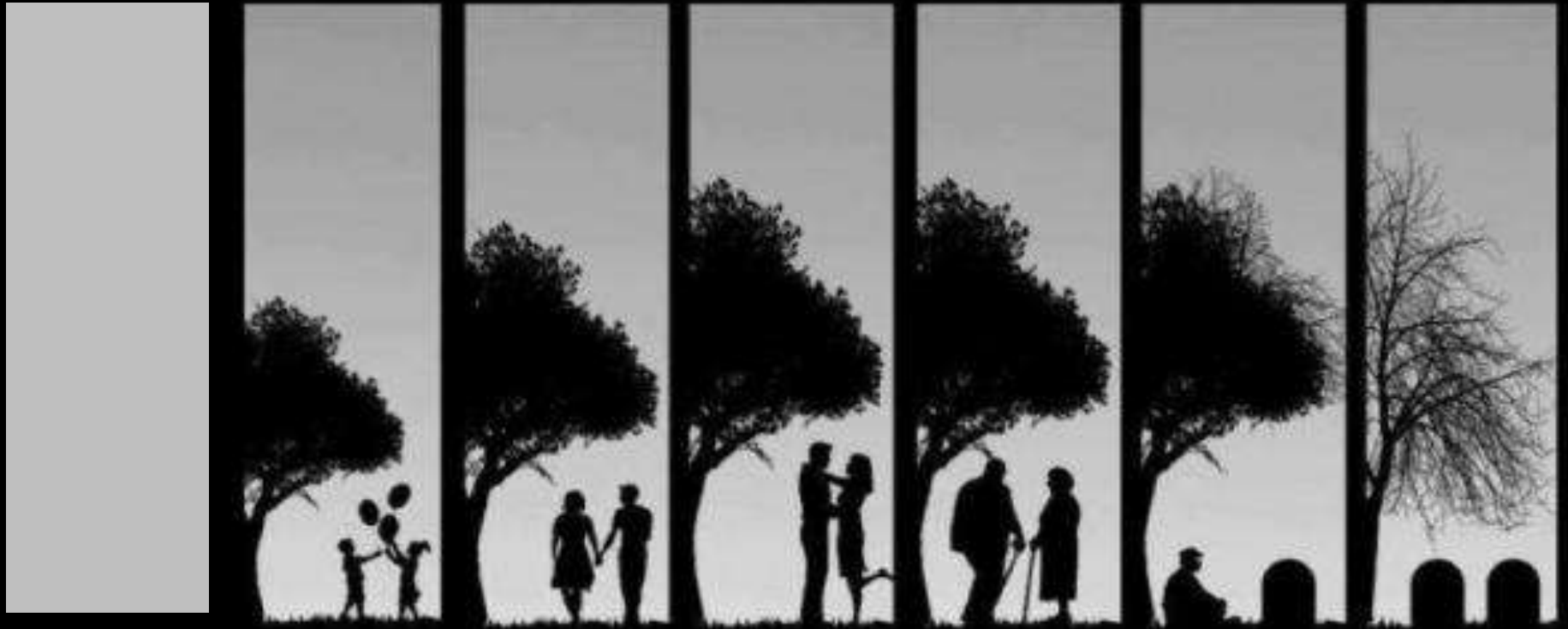
Courtesy Dean Bowman, Bentley Systems

Design

Construction

Customers

Maintenance & Operations



Contractors - Machine Guidance



Inspectors - Stake Diet



**Asset
Management**

**Performance
Based
Operations**

**Intelligent
Transportation
Systems**

Operations & Maintenance
ASSET\$

**Decision
Support**

**Performance
Measurement**

MAP 21

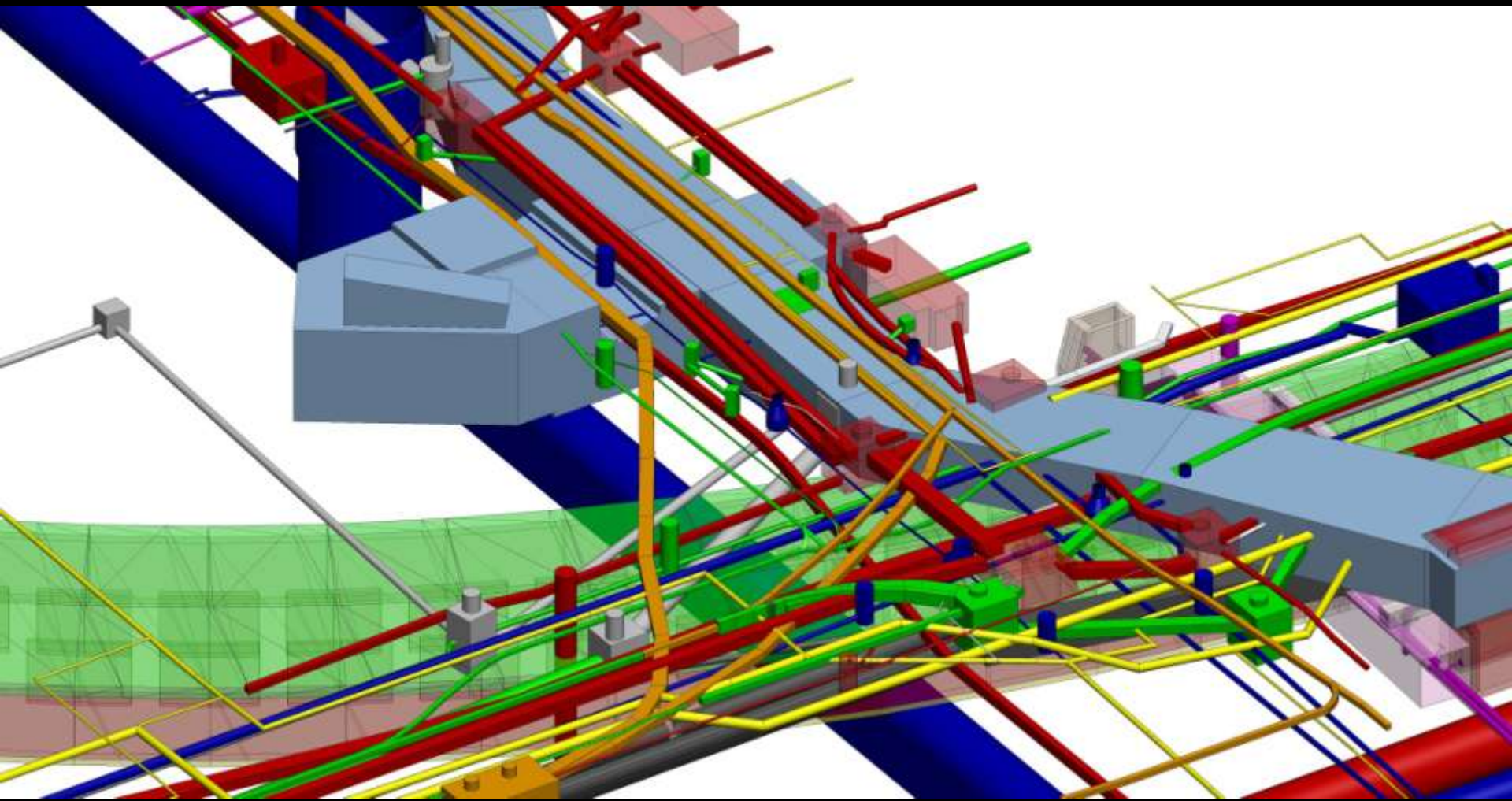
**Autonomous
Vehicles**

**Automated
Design &
Construction**

**Transparency
in
Government**



Hatch Mott McDonald
Northwest PATH Pedestrian Tunnel
Toronto, Canada



Hatch Mott McDonald
Northwest PATH Pedestrian Tunnel
Toronto, Canada

Challenges



- Change
- Training
- Standards
- 3D Model QA/QC
- Risk – Contractor V's DOT



Poll Pod

Creating and Delivering 3D Models

Alexa Mitchell, P.E.

MoDOT – CADD Services Engineer

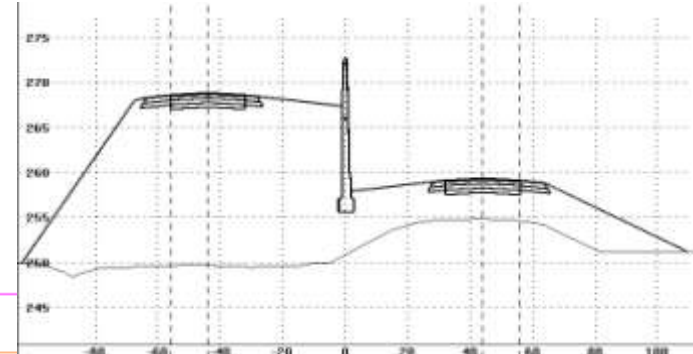
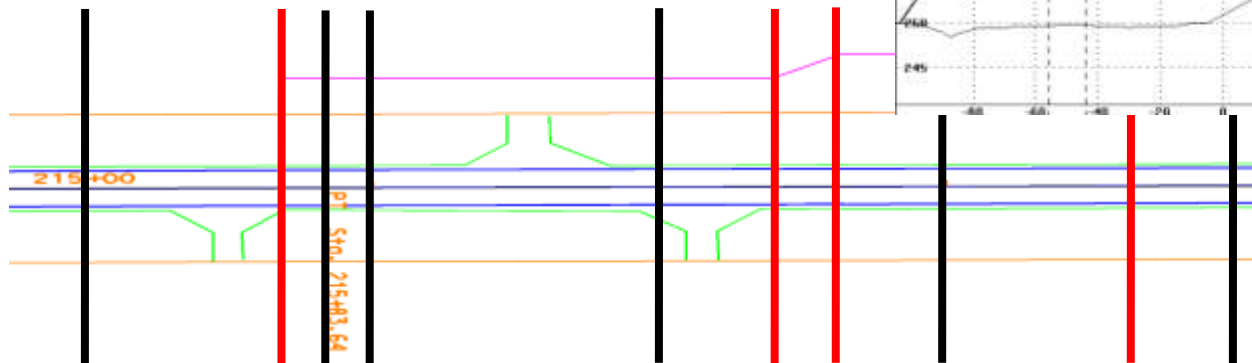


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Traditional Design Models

- Fragmented design – rigid – inefficient
- Lack of design intent
- Inhibit collaboration





Traditional Design Models

- Inhibit innovation and technology use
- Incomplete model for construction
- Increased bidding risk + change orders





Benefits of 3D Design Models for Construction

- Design model for multiple purposes
(PR, R/W, decision making)
- Design intent is communicated
- Decreased risk = competition
- Virtual construction = fewer change orders
- Provide opportunity for innovation
(ATC's, VE, AMG, etc.)



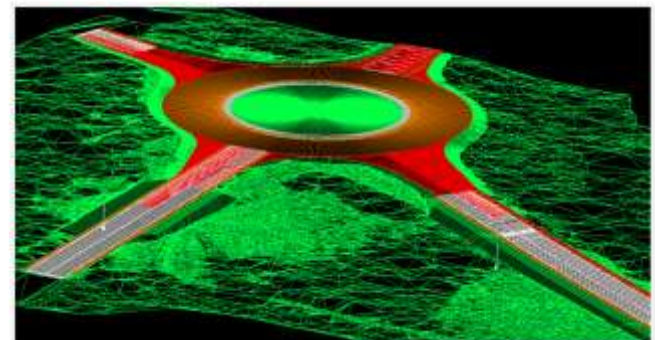
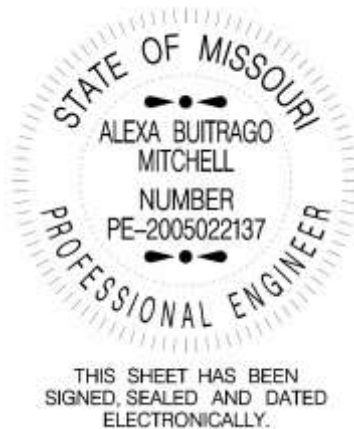
Technical Challenges

- Lack of guidelines or best practices
- Lack of \$ to set up technical infrastructure (storage, bandwidth, accessibility, etc.)
- Mismatched technological advances (software vs. hardware)
- Lack of expertise
- Lack of investment in training and technology
- Accelerated deadlines = no time to learn
- Lack of consistency from contractors (type of data & format – one size does not fit all)



Legal Challenges

- Electronic plans vs. electronic data
- Change orders and model modifications
- Validation of data and disputes
- Engineer of record





Conclusions

- 3D Models are better than traditional 2D models
- We have a number of technical, institutional and legal challenges we must overcome as an agency
- So it'll take the agencies time to completely move to 3D workflows, but we must start now



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Using 3D Models in Bidding and Construction

Eric Cylwik
Sundt Construction

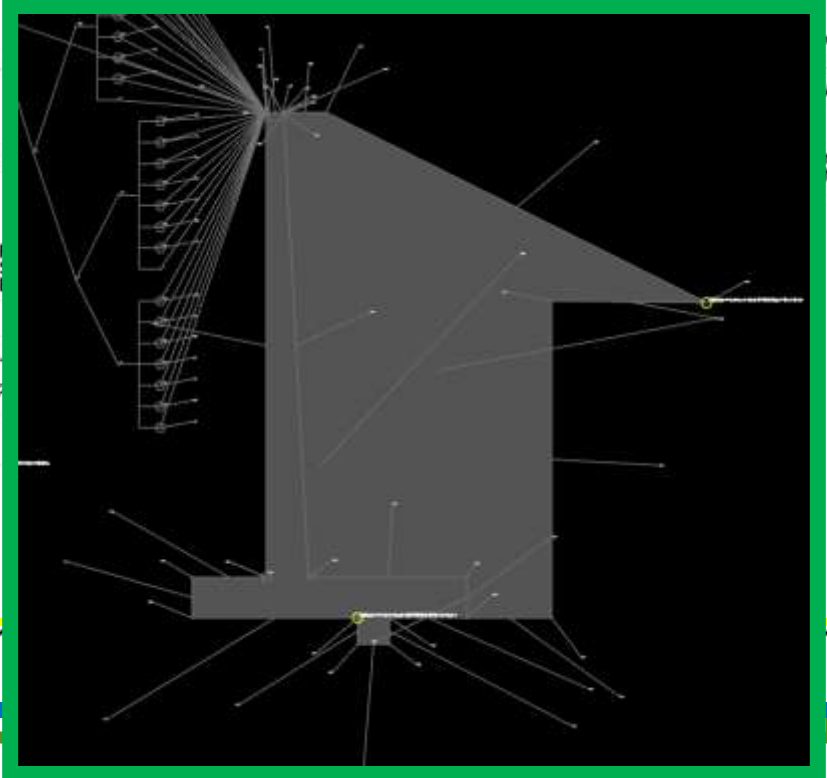


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Developing Models



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DesignSurface

Ret. Wall

Structure Backfill

Structure Ex.

ExistingSurface

TopOfWall

TopOfFooting

☐ Codes ☐ Comments

Fit to Screen

Preview Event Viewer

Target Parameters

Name	Type	Preview Value	DisplayName
TopOfWall	Elevation	10.385	
TopOfFooting	Elevation	-4.009	
H_Value	Elevation	20	
ExistingSurface	Surface	3	
DesignSurface	Surface	7.729	

SUNDT



From Construction Documents

RETAINING WALL 375RW06

Chain 375RW06 contains:
3750600 CUR 375RW06-1

Beginning chain 375RW06 description

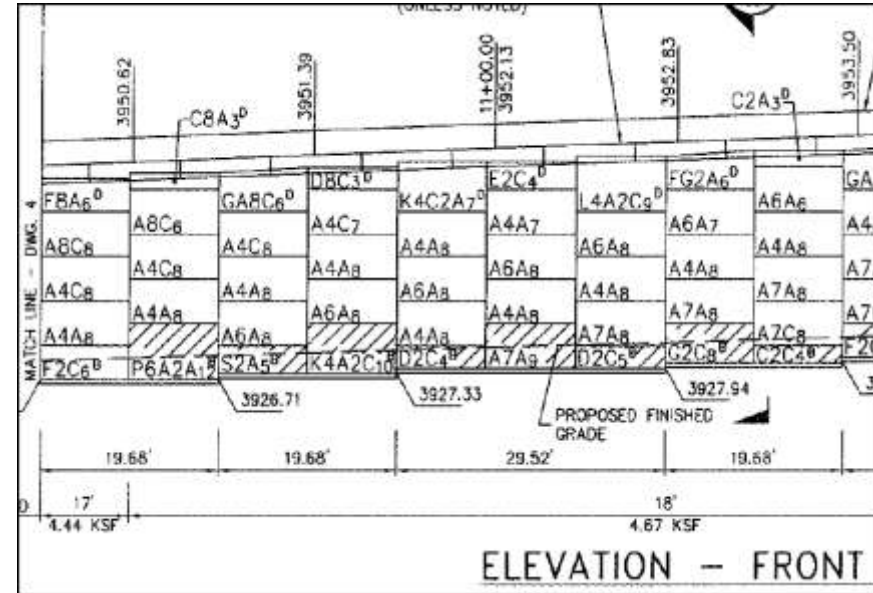
Point 3750600 N 10,714,550.8219 E 360,148.9207 Sta 10+00.00

Course from 3750600 to PC 375RW06-1 S 84° 41' 12.27" E Dist 157.4777

Curve Data				

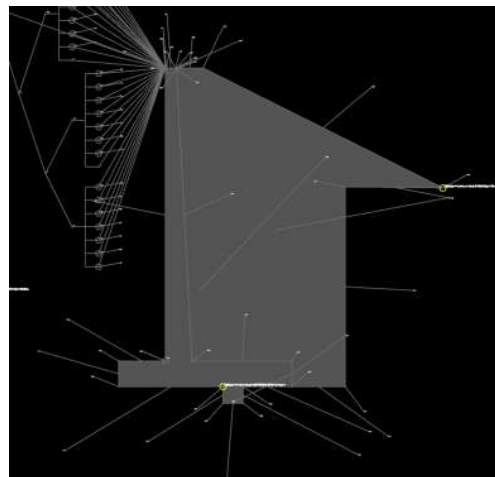
Curve 375RW06-1	11+72.80	N	10,714,534.8201	E 360,320.9821
P.I. Station				
Delta	0° 17' 35.33"	(RT)		
Degree	0° 57' 22.91"			
Tangent	15.3262			
Length	30.6523			
Radius	5,991.0000			
External	0.0196			
Long Chord	30.6523			
Mid. Ord.	0.0196			
P.C. Station	11+57.48	N	10,714,536.2393	E 360,305.7217
P.T. Station	11+88.13	N	10,714,533.3228	E 360,336.2350
C.C.			10,708,570.9809	E 359,750.9492
Back	= S 84° 41' 12.27" E			
Ahead	= S 84° 23' 36.94" E			
Chord Bear	= S 84° 32' 24.60" E			

Ending chain 375RW06 description



Alignment Data

Profile Data



Standard Detail



From Model

- Import Surface Data
 - LandXML, DTM, Etc...
- Import Alignment Data
 - LandXML, CSV
- Import Line Work Data
 - DGN, DWG, DXF

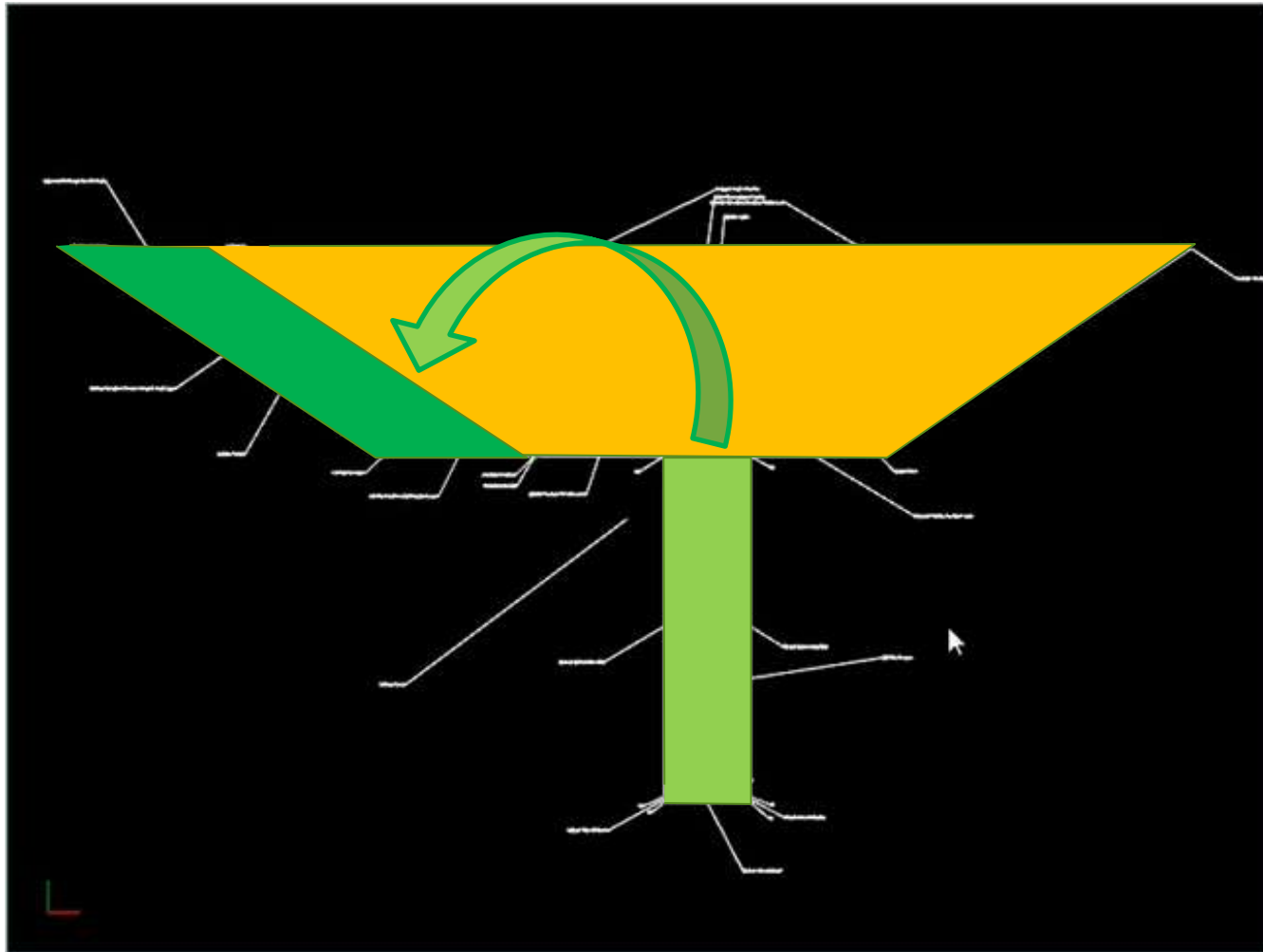
Using Models for Bidding



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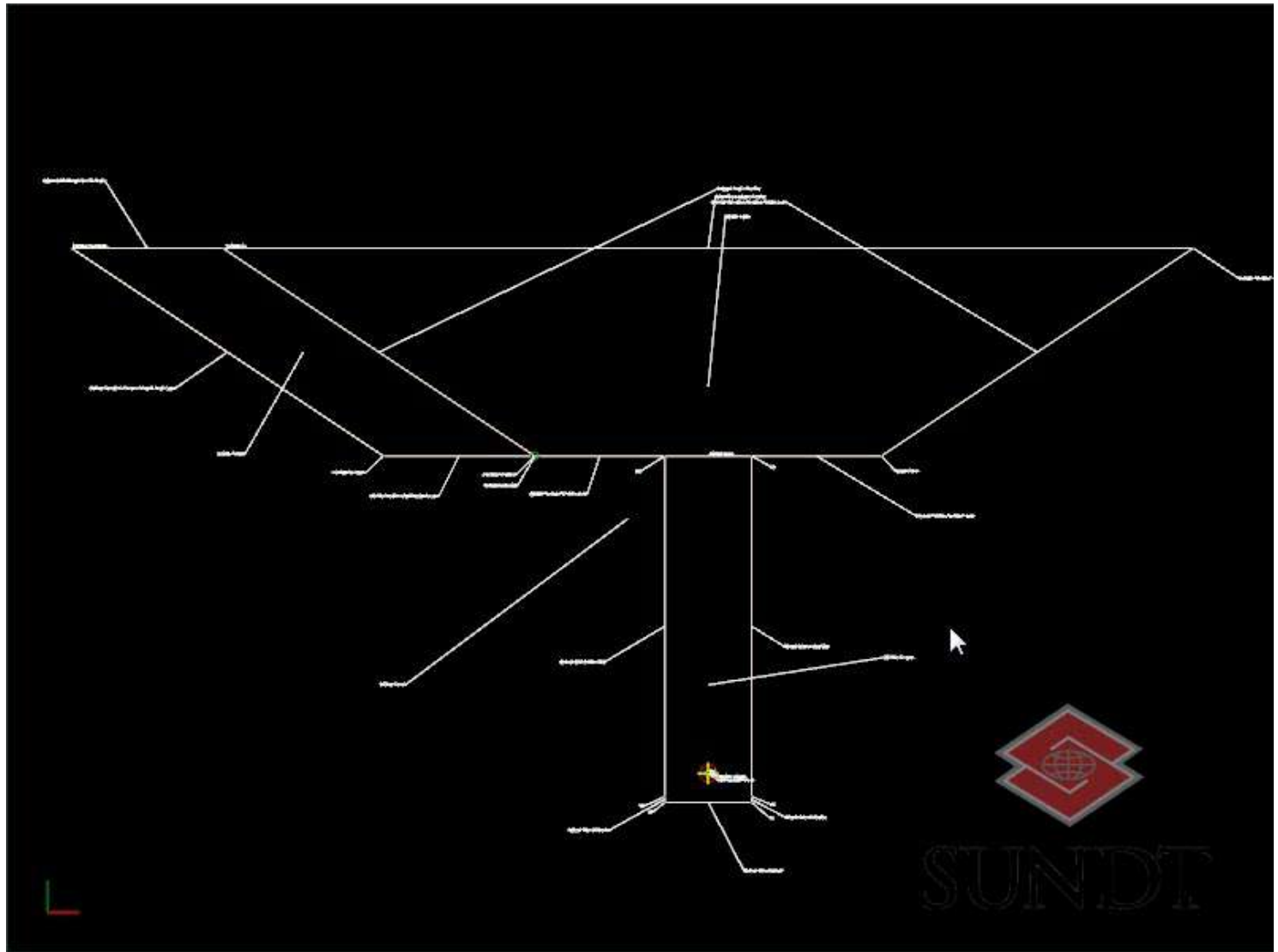


Use in Bidding – Means and Methods



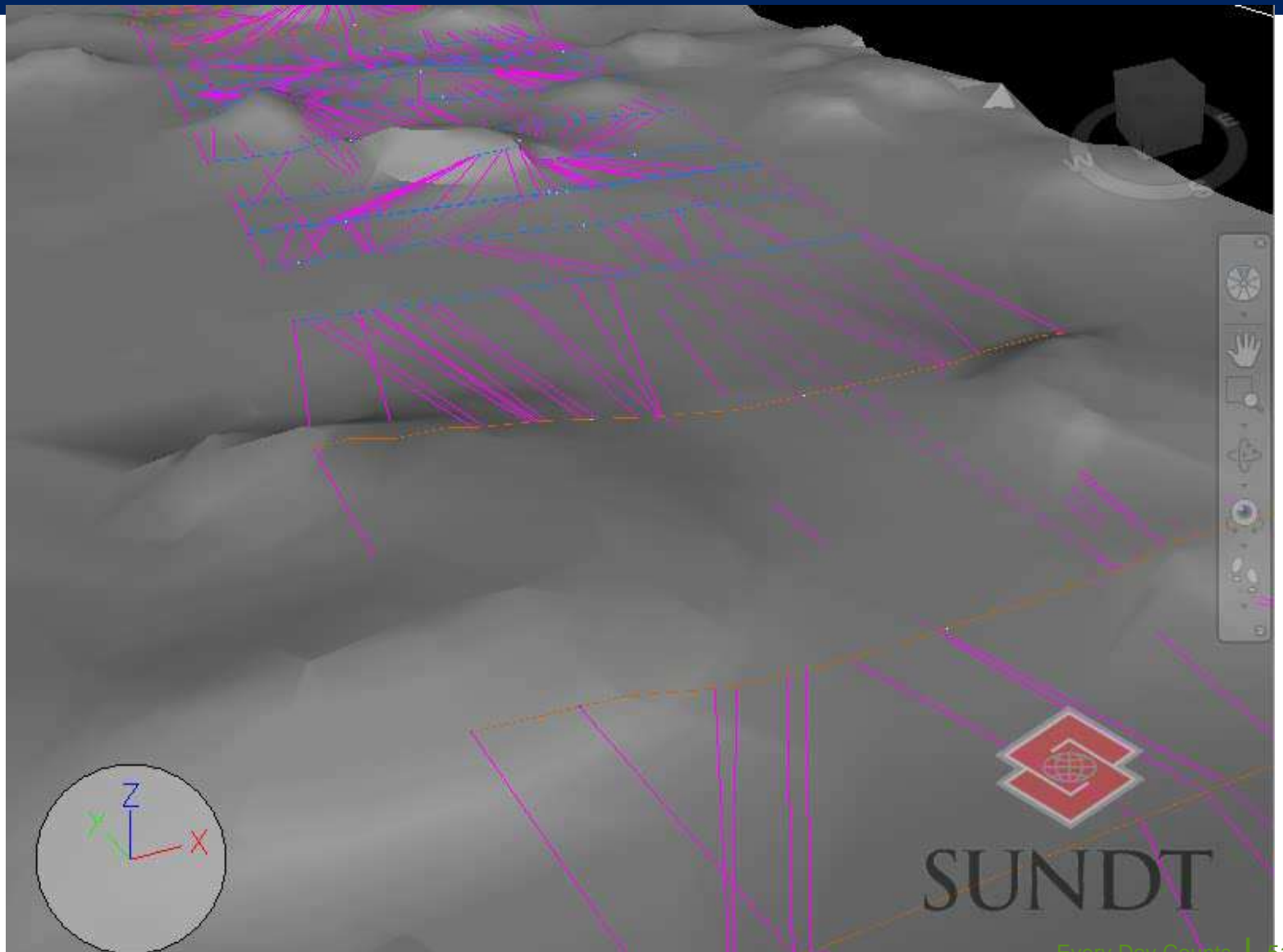


Use in Bidding – Means and Methods





Use In Bidding – Means and Methods



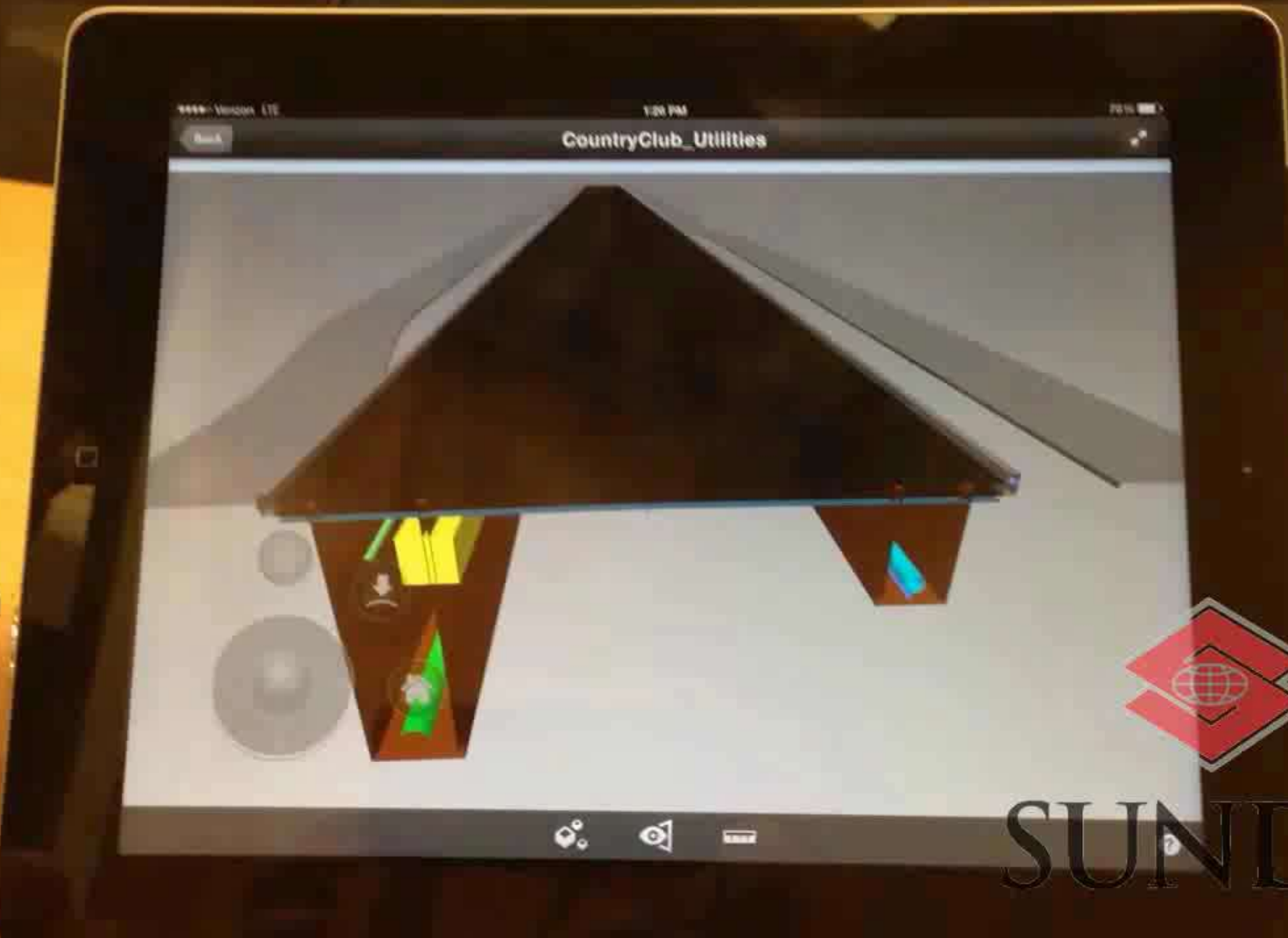
Using Models during Construction



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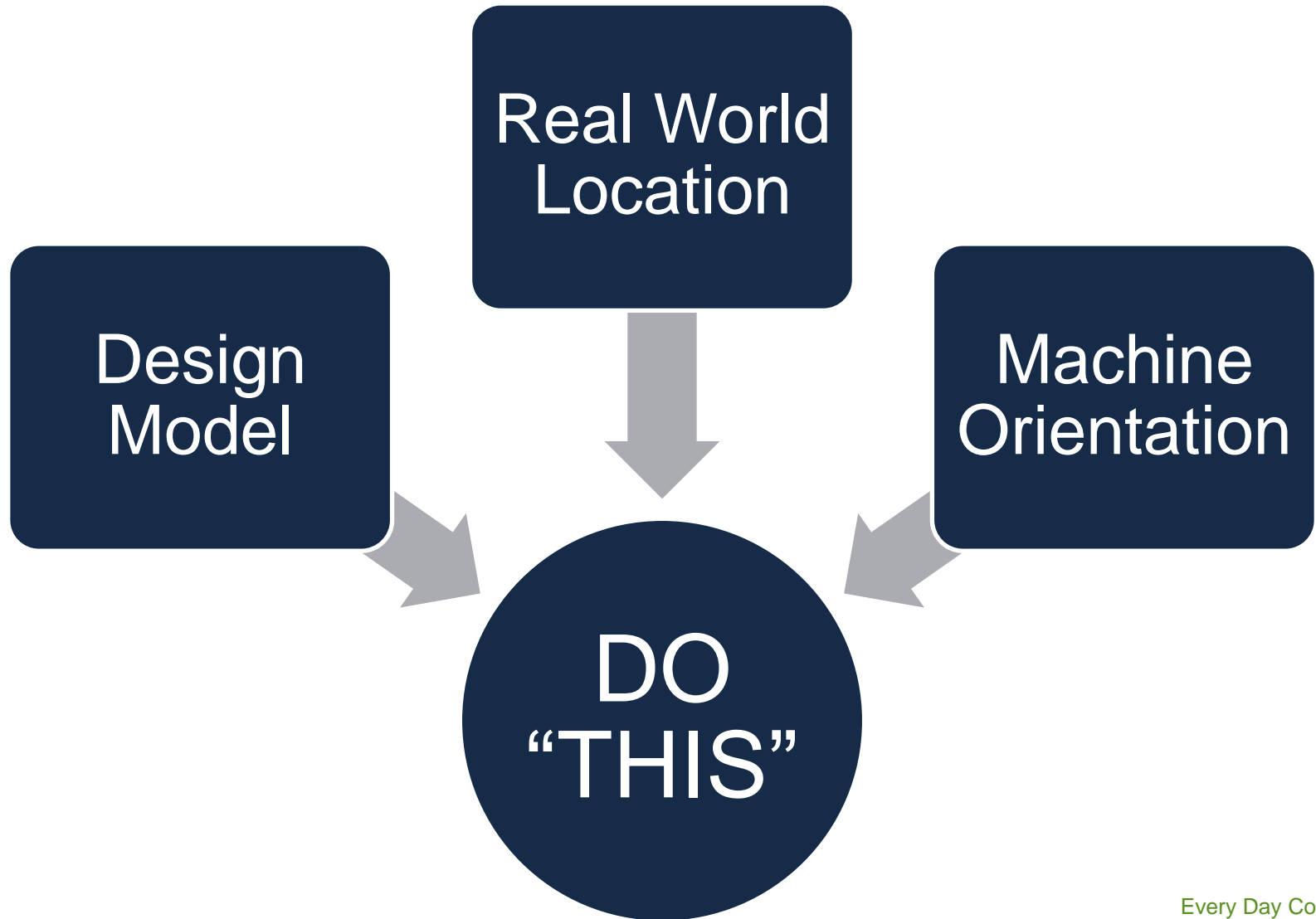


Use During Construction





Use in Construction







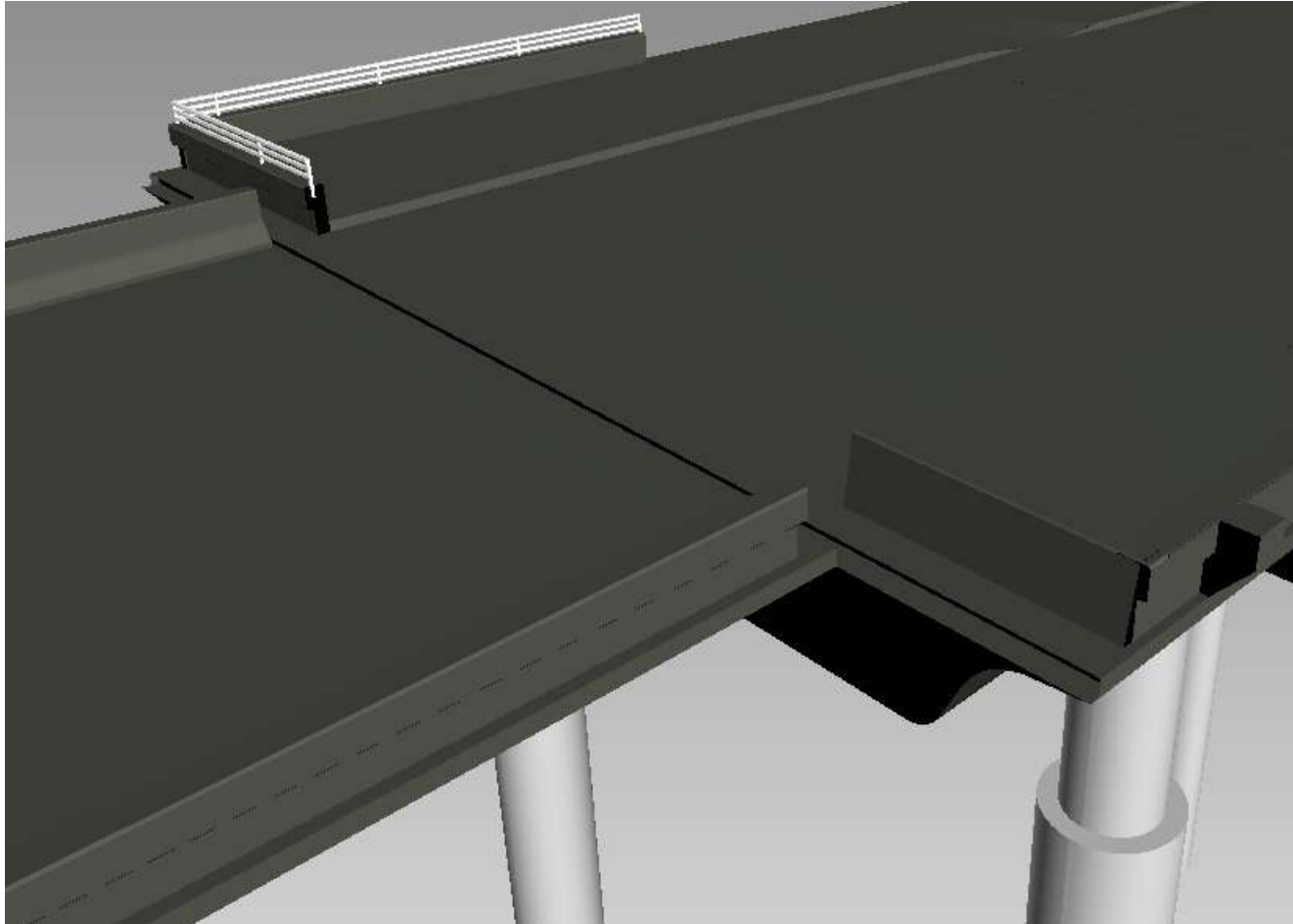


Bits to Atoms





Bits to Atoms





Bits to Atoms



SUNDT



Bits to Atoms





Bits to Atoms



Conclusion



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Benefits of Using Models

- Critical data input, reducing repetition
- Faster, more accurate, and more responsive estimates
- Deeper understanding of construction documents
- Reduce risk in planning and execution
- Right Here, Right Now information

3D Engineered Models for Construction Webinars

Douglas Townes, P.E.
FHWA Resource Center



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Webinar Topics

Webinar 1: Overview of 3D Engineered Models for Construction

Webinar 2: Creating 3D Engineered Models

Webinar 3: Applications of 3D Models in the Contractor's Office

Webinar 4: Applications of 3D Models on the Construction Site

Webinar 5: Managing and Sharing 3D Models for Construction

Webinar 6: Overcoming Challenges to Using 3D Engineered Models for Construction

Webinar 7: Steps to Requiring 3D Engineered Models for Construction

Webinar 8: The Future: Adding Time, Cost and other Information to 3D Model



2. Creating 3D Engineered Models

January 8, 2014, 1:00 – 2:30 pm

- Survey Methods
- Legal issues with sharing survey data
- Creating a DTM
- Creating 3-D Models
- Data Exchange formats





3. Applications of 3D Models in the Contractor's Office

February 19, 2014, 1:00 – 2:30 pm



- Contractor's perspective
 - Preparing models for estimates
 - Preparing models for clash detection
 - Preparing models for AMG
 - Benefits of using AMG



4. Applications of 3D Models on the Construction Site

April 2, 2014, 1:00 – 2:30 pm

- DOT perspective
 - Safety issues
 - Public outreach
 - Project staking, AMG & QA
 - Benefits of using AMG
 - 3D models on mobile devices





5. Managing and Sharing 3D Models for Construction

May 7, 2014, 1:00 – 2:30 pm

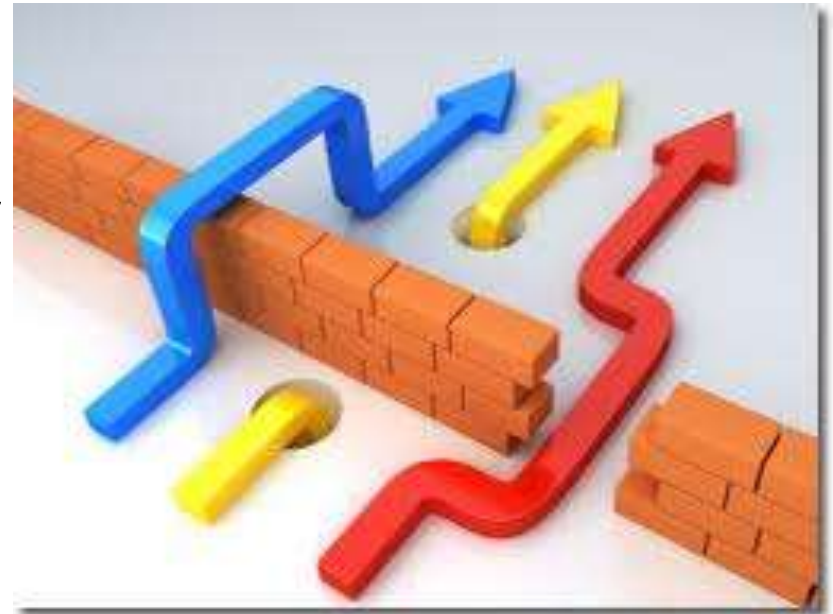
- The data structure for the 3D Engineered Model
- Sharing data in a point cloud
- Data formats and data exchange
- Specifying 3D models by element and LOD
- Certifying electronic documents
- Validating construction models



6. Overcoming Challenges to Using 3D Engineered Models for Construction

September 10, 2014, 1:00 – 2:30 pm

- Overcoming technological implementation barriers
 - DOT issues
 - Contractor issues
- Developing a plan for implementation
- Resources for overcoming barriers





7. Steps to Requiring 3D Engineered Models for Construction

October 15, 2014, 1:00 – 2:30 pm

- Identifying champions
- Evaluate pilot projects
- DOT Specifications, policies & procedures
- Contract language to accommodate technology and manage liability





8. The Future: Adding Time, Cost and other Information to 3D Model

November 19, 2014, 1:00 – 2:30 pm

- 4D
- 5D



Participant Interaction

Francesca Maier, P.E.
Parsons Brinckerhoff

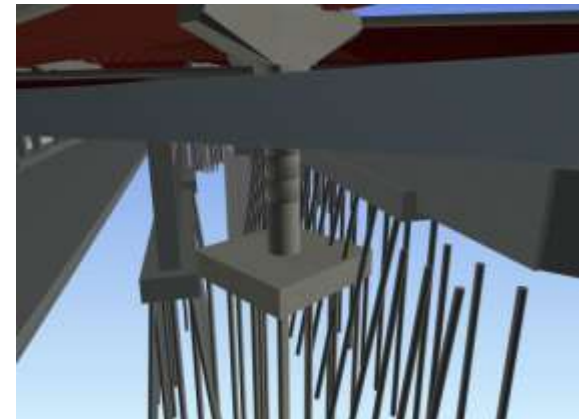
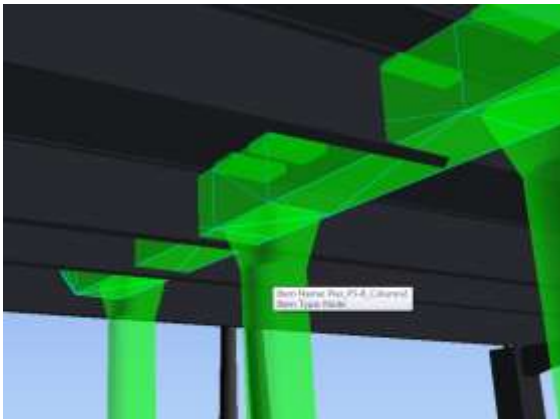


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Summary of Benefits

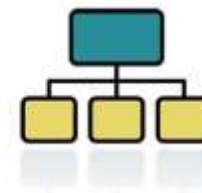
- Better communication of the design intent
- Reduced clashes
- Savings of up to 30% on earthworks
- Better construction quality
- Enhanced safety





Summary of Challenges

- Technological challenges
 - Enabling infrastructure
 - Education and training
 - Data management
- Institutional challenges
 - Creating standards and specifications
 - Changing workflows
 - Legal frameworks
 - Time and fiscal constraints





Participant Interaction

- Poll pods
- Question and Answer



Webinar Series

Overview of 3D Engineered Models for Construction	Today
Creating 3D Engineered Models	January 8, 2014
Applications of 3D Models in the Construction Office	February 19, 2014
Applications of 3D Models on the Construction Site	April 2, 2014
Managing and Sharing 3D Models for Construction	May 7, 2014
Overcoming Impediments to Using 3D Engineered Models for Construction	September 10, 2014
Steps to Requiring 3D Engineered Models for Construction	October 15, 2014
The Future: Adding Time, Cost and Other Information to 3D Models	November 19, 2014

Contact: Douglas Townes, Phone 404-562-3914, douglas.townes@dot.gov
<http://www.fhwa.dot.gov/everydaycounts/edctwo/2012/3d.cfm>